THE RAPID FILTER PLANT AT EVANSTON, ILLINOIS

By Langdon Pearse[1]

The installation of a filter plant was urged because of the poor condition of the water in Evanston, both from the hygienic and aesthetic standpoints. The intake is only one and one-sixth miles offshore, well within the range of drift for the sewage of Evanston and Wilmette, the greater portion of which is discharged on the lake front. In the winter of 1911–1912 a severe threatened epidemic of typhoid was averted only by the emergency use of chloride of lime.[2] From time to time breaks in the intake pipe have been found, thereby receiving water nearer inshore.

When the matter was agitated in 1912, Mr. W. W. Jackson and the writer made a report, in August of that year, recommending the construction of a plant of the rapid-filter type. By a popular vote, in the same fall, a bond issue was authorized. Plans and specifications were prepared by Mr. George W. Fuller, of New York City, and the writer, on which bids were received in April. Active construction work commenced in June, 1913, under our direction, with Mr. C. G. Gillespie as the resident engineer, the work being substantially completed in August, 1914. Since that time, Mr. Gillespie has been in charge of the operation of the plant.

Doubtless the water works man will ask why the plant was made of 12,000,000 gallons capacity for an estimated population of about 30,000. The reason for this is the abnormal daily average pumpage in the summer time, the daily average frequently running 12,000,000 gallons per day for a continued period of hot weather, with peak loads for four hours as high as 17,000,000 gallons per day in the afternoon, and on one day after the plant went into service lasting twelve hours. The average daily pumpage by the year has been about 6,000,000 gallons per day for the last ten years (Fig. 1), the effect of increase in population having been taken

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[2] See *Proc. Ill. Water Supply Assn.*, 1912.

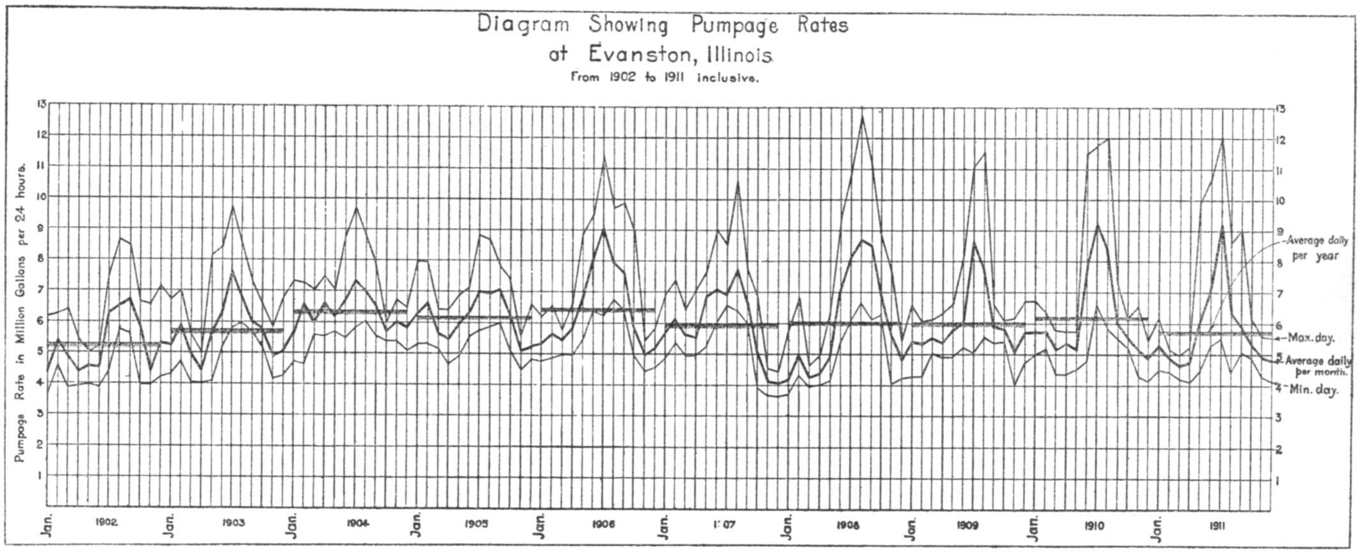

Fig. 1. Diagram Showing Pumpage Rates at Evanston, Illinois.

care of by inspection of services and leaks. This large use of water is due principally to lawn sprinkling, since the pumpage drops suddenly in summer time on cloudy, and particularly on rainy days (Fig. 2). With the condition in mind of continued daily loads, and the possibility of a healthy growth of population, 12,000,000 gallons capacity seemed a nominal size for this community. This rating is based on the usual rating of 125,000,000 gallons per acre per day.

The filter plant is located on Sheridan Road about one mile north of the center of the city on a site adjoining the Northwestern University and 300 feet from the existing city pumping station. A low-lift pumping station built adjoining the present pumping station is equipped with three centrifugal pumps, one of 10,000,000, one of 8,000,000, and one of 6,000,000 gallons per day capacity, with a total lift varying from 25 to 40 feet. These are geared to steam turbines, with a guaranteed duty in excess of 69,000,000 foot pounds per 1,000 pounds of dry steam for the large units operating condensing with 26 inches vacuum or over. A surface condenser is used, placed directly in the force main, inside the pumping station. A 30 inch cast iron force main conducts the raw water to the entrance to the mixing chamber, a Venturi meter being placed on the line to measure the pumpage.

The mixing chamber (Fig. 3) is about 96½ feet by 14 feet in size, with a depth of 18 feet, having a total capacity of approximately 170,000 gallons, giving a nominal mixing period of twenty minutes. The basin is constructed entirely of reinforced concrete, divided into bays by wooden baffles to maintain velocities of approximately 1 foot per second. The mixing chamber lies between and is part of two coagulating basins (Fig. 4) each about 39½ by 96½ feet in size, and 15 feet deep, having a combined capacity of approximately 830,000 gallons, giving a nominal period of sedimentation of one hour and forty minutes. These are constructed entirely of reinforced concrete with a groined arch roof, each compartment being divided by two concrete baffles into three bays to insure circulation

The coagulated water flows in a concrete channel across the space left for the extension of the filters to six rapid-filter units, each 23½ by 36 feet inside dimensions, having an aggregate filter surface of 4425 square feet. The filters are grouped on both sides of a pipe gallery, over which is a platform with an operating table for each filter. All the filter tanks, floors and roof are of reinforced

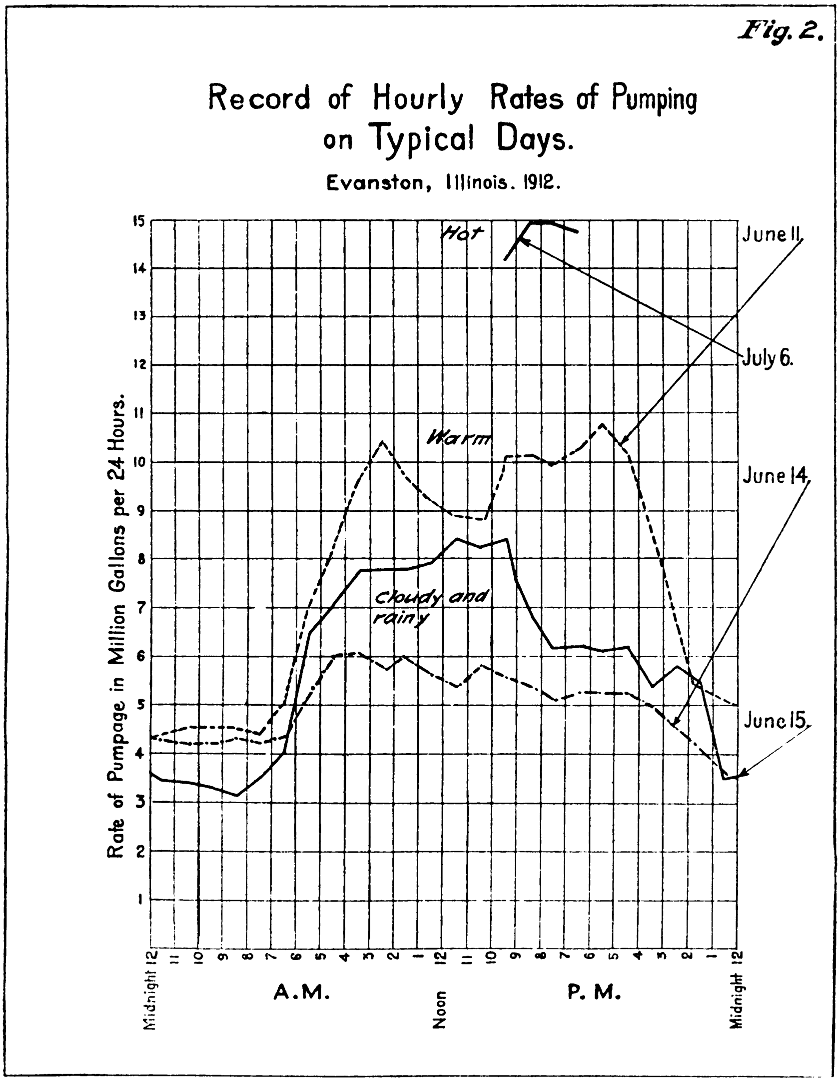

FIG. 2. RECORD OF HOURLY RATES OF PUMPAGE ON TYPICAL DAYS, EVANSTON, ILLINOIS, 1912.

concrete. Hydraulic valves are used throughout, the controllers for the filters being of a modified Vivian type. The wash water drain, filtered water conduit and raw water conduit are built one over the other, forming a reinforced concrete structure down the center of the pipe gallery. The house covering the operating floor and a part of the filters is of brick with a concrete roof, the inside being lined with a light yellow vitrified brick. The design is so made that the operator can see the entire filter bed at time of washing.

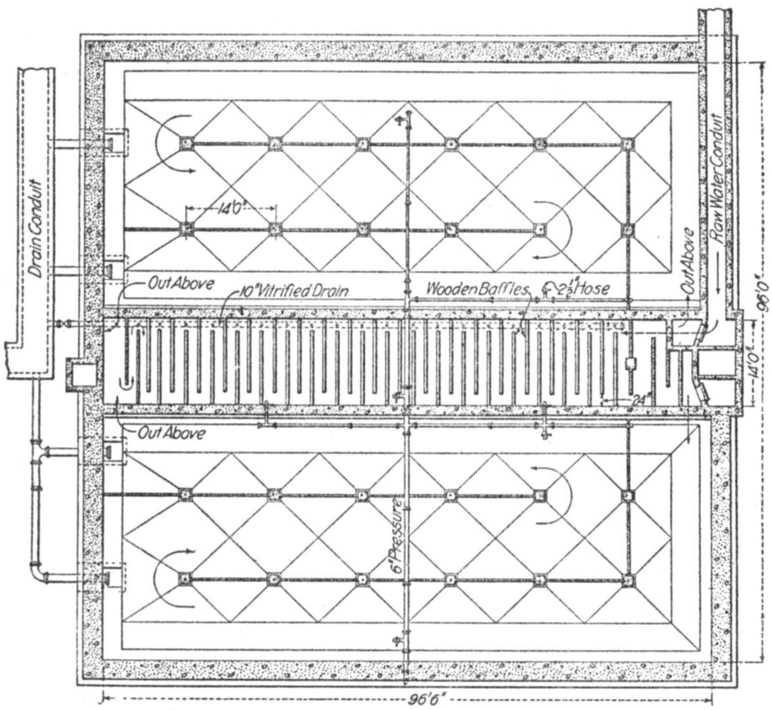

FIG. 3. PLAN OF MIXING CHAMBER AND COAGULATING BASINS, SHOWING BAFFLES.

Both filters and head house are placed above a covered filtered water reservoir, 154 by 161 feet in plan, 12 feet deep, divided into two basins having a total capacity of approximately 2,000,000 gallons. This basin has a groined arch roof, reinforced where necessary to carry the weight of the head house and filters. The standard spacing for the arches is 12 feet 6 inches on centers, with a rise of

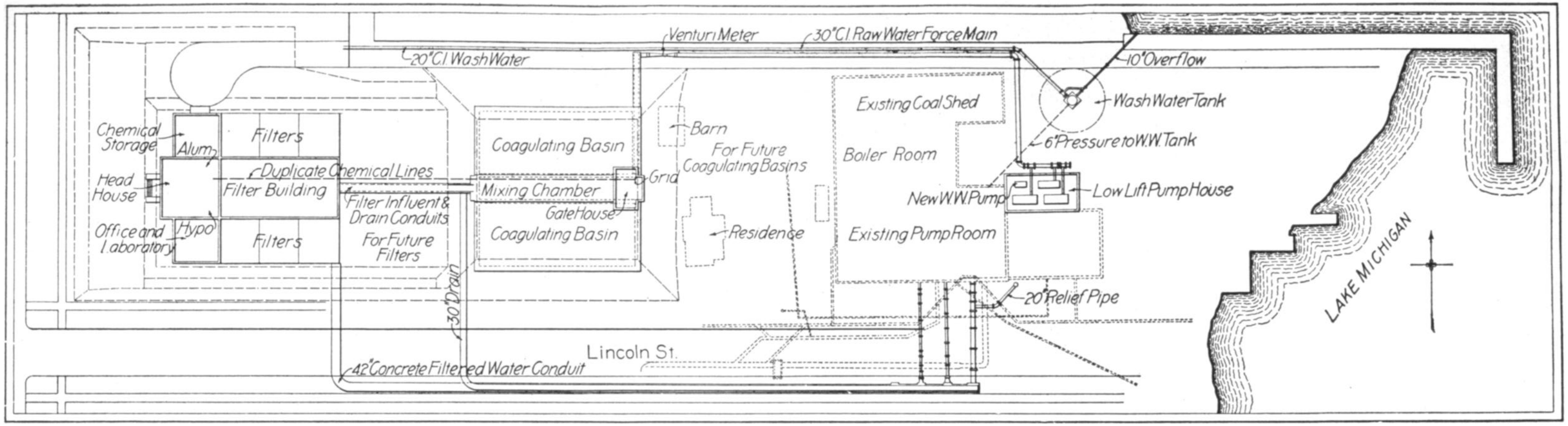

FIG. 4. RELATION OF TANKS, FILTERS AND MECHANICAL EQUIPMENT OF EVANSTON FILTER PLANT

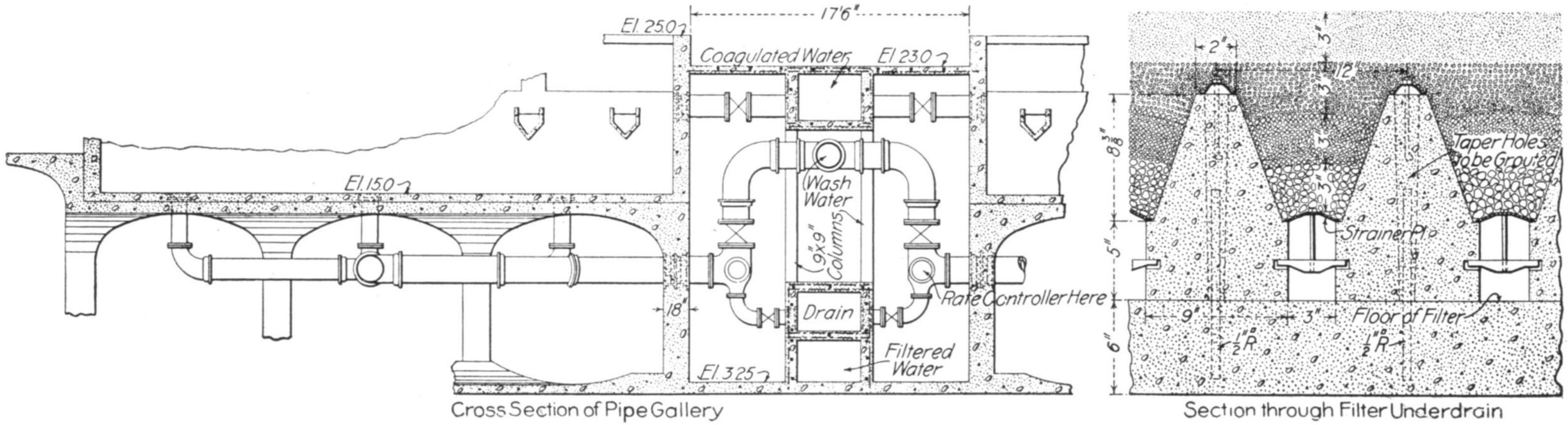

FIG. 5. CROSS SECTION OF RESERVOIR, PIPE GALLERY AND UNDERDRAINS, EVANSTON FILTER PLANT

2 feet 9 inches and a thickness of 6 inches at the crown. The foundation is of firm clay so that the thickness of the floor arches is only 6 inches at the thinnest point.

The two story head house at the head of the filter gallery has two wings, one story each, built of reinforced concrete and brick with prepared roofing. The dimensions of the head house are approximately 28 by 91 feet, and of the filter wing 75 by 36 feet. In the head house are placed the tanks and apparatus for the proportioning and application of the coagulating and sterilizing chemicals, the recording gages, laboratory office, and chemical storage. The second floor of the head house is served by a hydraulic elevator.

The design of the rapid filter units includes an under drain system with perforated brass plates, set at the bottom of valleys in the fashion of the Minneapolis, Grand Rapids, and other plants (Fig. 5). A novel feature, however, is the omission of the wire screen and the use of 12 inches of graded gravel, on top of which the sand is placed. The wash is a high-rate water wash, supplied by a gravity feed from a steel tower tank of 100,000 gallons capacity erected behind the present pumping station on the lake front. It is fed by a bleeder from the present high service mains. Fluctuations in the pressure due to the drop of level in the wash water tank are taken care of by a controller to be placed in the line at the entrance to the filter gallery (Fig. 5).

The work was carried on under a general contract. Owing to the situation, it was impossible to bring material in except by teams, a haul of approximately one mile from the nearest railroad switch being required. Owing to lack of storage room the contractor developed a plant for the elevating and storage of the gravel and sand in bins to minimize the handling by hand. The teams dumped into a hopper from which a belt conveyor delivered the material to the sand or gravel bins. Storage sheds for cement were built alongside the bins. A concrete mixer discharged into two-wheeled buggies on an elevator for raising or lowering the cars of concrete to the appropriate level for placing. One inch yellow pine flooring was used for form work wherever possible, with 2 by 4 inch studs spaced about 16 inches on centers tied with very heavy wire.

The inverted groined-arch column bases were formed up continuously in rows by the use of a "spider," a metal frame consisting of 1-inch angles making a square, from each corner of which malleable castings of the shape of the groin converged to the base

at the center, where they were held together by plates. In use, the angle frames were set on the two 6-inch floor form strips and held there by pins. After running a cut-off strip over each pair of legs and getting the base shaped, the form was removed to the adjoining base and the corners smoothed up.

The groined-arch forms (Fig. 7) for the roof were built in a manner different from that usually employed on such work. The form units were framed in the carpenter shop and transported to place on a pair of wheels. They filled the squares between the column corners, leaving a width approximately that of the column to be

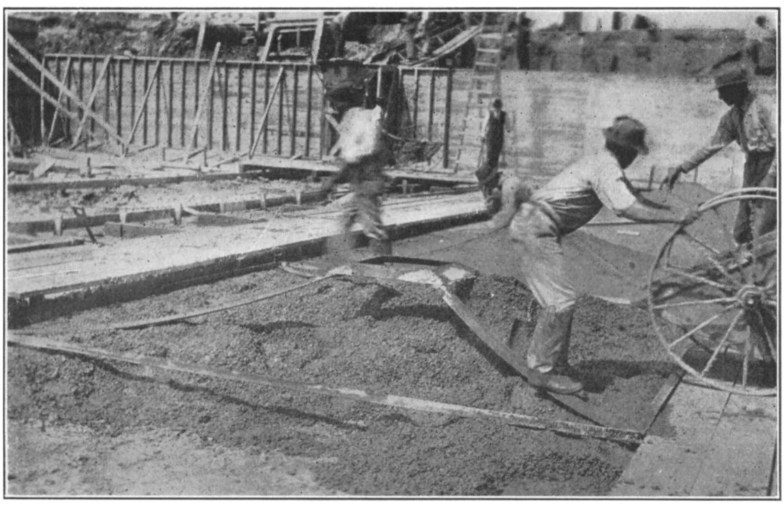

FIG. 6. STEEL SCREED FOR INVERTED GROINED ARCHES

filled on the job, with short pieces of 1-inch flooring nailed in place by carpenters (Fig. 8). This method was feasible because of the short span. The groined-arch forms were carried on stringers resting on the vertical tie studs of the column forms. The forms were stripped at a minimum time of five to seven days, ten days being secured wherever possible. For the construction of the 30 inch wash water drain and 42 inch filtered water conduit, suitable circular collapsible forms were built of wood. At the bends a built up form was made of laths, plastered smooth with ivory wood fiber plaster, smoothed up with paraffine wax dissolved in kerosene. The forms were destroyed before removal.

In the construction of the chemical solution tanks in the head house and the valve chamber at the entrance to the mixing chamber, the contractors used a novel adaptation of the moving form used in grain elevator construction. The form (Fig. 9) consisted of well braced sheets making an inside and outside form 4 feet high. This was supported by hangers carried on jacks which were moved upwards on stout iron rods embedded in the concrete. The twisted

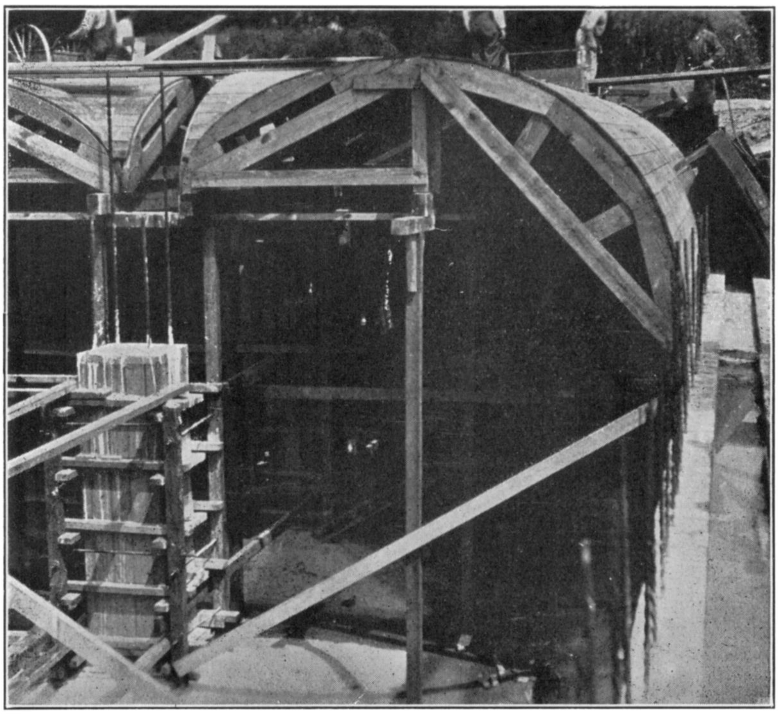

Fig. 7. Forms for Groined and Barrel Arches

steel was placed as the form moved upward. The idea was to move the form upward at such a rate that the concrete exposed below the form would be set sufficiently to be self supporting. As a result, a very smooth finish was obtained at small cost. Clearly such a method is easily applicable only where a structure has the same plan throughout its height. In the case of the solution tanks the form was jacked upward day and night for five days through a height of about 13 feet. A similar device was used to build the

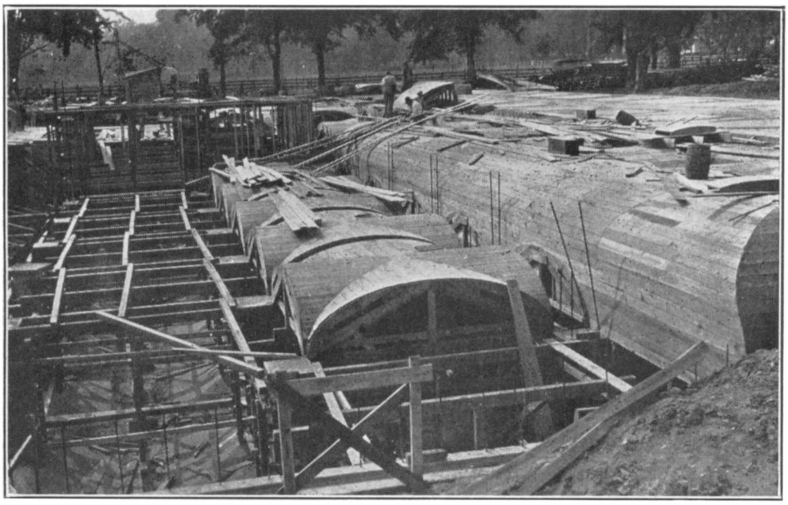

Fig. 8. Adjustment Space Between Arch Forms

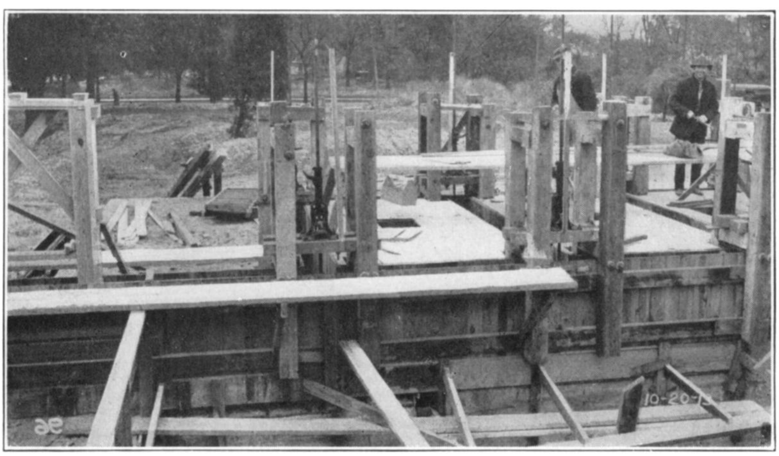

Fig. 9. Moving Form for Chemical Solution Tanks

reinforced concrete baffles in the coagulating basins, the reinforcing, however, being placed first and each side form being jacked up separately. The device worked well on the baffles and on three out of five solution tanks. Despite three coats of asphaltum paint, two tanks showed a few leaks which proved generally to be on horizontal lines, where the moving form had pulled. In one tank these were stopped by liberal applications of asphaltum, applied hot.

In the filter boxes the gutters were cast in place prior to the forming of the underdrains. Neat rounded edges were secured by a

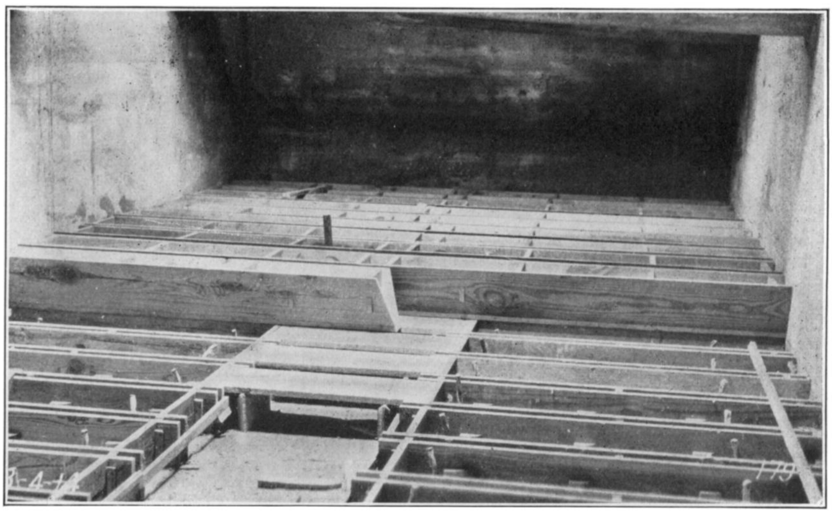

Fig. 10. Ridge Block Form, Evanston Filters

metal screed tool. The underdrain system was cast in place, complete, instead of casting the spanning block outside and placing later. The procedure was as follows. Holes were drilled in the floor to receive the dowels. For this work a small 40-pound steam drill was found most economical. In these holes, the dowels were grouted, a test being made after ten days set. Then the brass deflector plates were set over the three rising pipes in the bottom of the filter, and the bottom thoroughly cleaned. The forms were then built up as shown in Figure 10. The bottom pieces to form the waterways were carefully adjusted and set in lime cement mortar. They were separated by removable wedges. On these sat the block forms.

The entire wood forms were made up for three one-quarter filter units, and were thoroughly treated with one part kerosene and two parts paraffine applied hot. Small blocks were left to form the indents for the yokes. The essential points were to preserve full waterways and obtain true level seats for the brass strainer plates.

The excavation was made on all the mass work with a Thew shovel, loading two-horse bottom-dump wagons with which the spoil was carried to adjoining lots or dumped on the lake front. The earth was fairly stiff, so that no sheeting was required except in trenches left open for days. The upper 5 feet of excavation was loam and

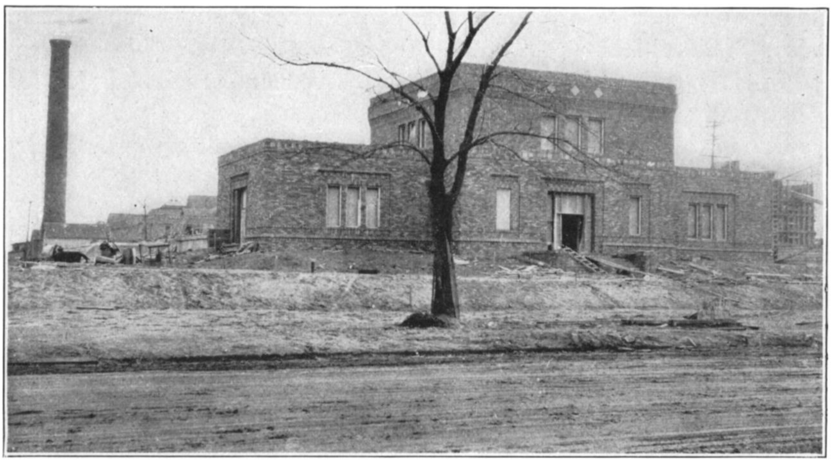

FIG. 11. HEAD HOUSE, EVANSTON FILTERS

sand containing some water, under which a clay stratum was found, free from water. Some of the sand from the excavation was suitable for use in the concrete, but the major portion of the concrete was made with torpedo sand and gravel brought from pits along the Fox River. The imported sand was found somewhat unsuitable, owing to the lack of fine material, so that a mixture was made of one part plastering sand and five parts torpedo sand for general use. This made a nicely working tight concrete.

The filter gravel was brought from the Atlantic beaches near Cape May, in New Jersey, but required hand cleaning before placing, to remove shells, dried seaweed and other foreign material. The sand was brought largely from Crystal City, Missouri. At first

this contained considerable fine material. After removing about 25 per cent by continued washing the effective size was about 0.43 mm., with a uniformity coefficient around 1.44. With a small proportion of Cape May sand added the effective size was increased to 0.47.

In the application of the solutions, through long lines at distant points, the novel feature is the use of lead solution lines, fed by an ejector. This introduces into the lines sufficient water to keep a high velocity. Such lines should be kept straight as far as possible. Incrustation occurred early with both "hypo" and "alum" lines. Rodding of the lines so far has kept them clear. A riser, 6 inches high, inside the solution tanks on the outlet pipe, helps also. The grids for application of coagulant and chloride of lime were early removed, for cleaning, and have not been replaced. In the mixing basin thorough mixing ensues.

One of the most interesting points was the strainer system. Prior to the construction, the existing underdrains of this type were studied, their history developed and provision made for the use of soft brass strainer plates of increased thickness, as well as for increasing the net area of the holes, and placing brass baffle plates over the pipes through the filter bottom. Some of the data collected is summarized in Tables 1 and 2. The original Minneapolis plate was a so called Tobin bronze and showed a very low ductility. Judging from previous strainer construction the details planned for Evanston were entirely safe and reasonable.

After the beds were put in operation, a number of the $\frac{1}{4}$-inch bolts broke, chiefly because of imperfections at the head, practically none breaking at the root of the thread. In view of the seriousness of breaks caused by flaws in the metal, the $\frac{1}{4}$-inch bolts were replaced with $\frac{3}{8}$-inch diameter Parsons bronze bolts, with heavier yokes. The tests of the bolts are given in Table 3. These show a more ductile metal in the smaller bolts. The work was rebuilt, every care being taken to insure true work to avoid secondary or eccentric stresses. The wash water valves were also adjusted to prevent water hammer by quick opening. At no time has a pressure on the plates been observed over 5 pounds per square inch. Yet a number of $\frac{3}{8}$-inch bolts have broken, some at the root of the thread, some by irregular jagged breaks, practically all showing a non-uniform crystalline fracture, a large portion being large crystals. Bolts actually broken in test showed a very uniform fine-

grained texture. Bending tests showed that some bolts could be bent double, while others snapped before 90 degrees was turned. In no case is there anything to indicate the metal has been overstrained, as the cross-section is practically unchanged. Hence the only conclusion is that the Parson bronze metal bolts are very variable in physical properties, proving frequently defective without warning. Monel metal bolts are now being used to replace breaks.

Subsequent investigation showed that considerable difficulty had been experienced on general water supply work by the Board of

TABLE 1

Physical and chemical tests of strainer plates from Louisville, Minneapolis and Cincinnati

Physical Tests

FILTER PLANT	LOUISVILLE	MINNEAPOLIS	CINCINNATI
Birmingham wire gage	14	16	15
Dimensions, in	0.084 x 0.737	0.066 x 0.75	0.079 x 0.514
Area, sq. in	0.062	0.046	0.040
Reduction of area, per cent	45.2	10.8	52.5
Elastic limit, lbs. per sq. in	54850	47800	40650
Ult. strength, lbs. per sq. in	60100	55450	56250
Elongation in 2 in., per cent	27.5	10	35.5
Fracture	Silky	Broke at perforation	Silky

Chemical analysis in per cent

Copper	65.48	60.81	66.96
Tin		0.77	
Lead	0.21	Trace	0.14
Iron	0.08	0.05	0.26
Zinc	34.23	38.37	32.64

Water Supply of New York City, and that bolts even as large as 2 inch diameter had broken under no strain (See Brass in *Engineering Construction* by A. D. Flinn, Municipal Engineers, City of New York, Feb. 25, 1914). This points to the need of the utmost care in selecting non-corrosive alloys of high strength, even from careful manufacturers, and the present indications are that such metal should be used with great caution.

The operating results obtained at Evanston are of interest as this is the first large modern plant on Lake Michigan. One of the first

TABLE 2

Data on Strainer Plates

FILTER PLANT	RATE OF WASH. VERTICAL RISE INCHES PER MIN.	STRAINER PLATES: Spaced on centers inches	Holes: Diam. in.	Holes: No. per ft.	Gage, B.W.G.	Thickness inches	Bolts: Spacing c/c	Bolts: Diam. in.	Channel width inches	Opening holes; per cent of filter area	Loss of Head Through Plate for Wash Rate: Feet	Loss of Head Through Plate for Wash Rate: Based on C=0.74
Cincinnati	24	12	$\frac{3}{32}$	64	15	0.072	12[4]	$\frac{1}{4}$	$2\frac{3}{4}$	0.3	$\left(\frac{1.39}{c}\right)^2$	3.65
Louisville	24	$11\frac{1}{4}$	$\frac{3}{32}$	54	14	0.083		$\frac{1}{4}$	$2\frac{1}{2}$	0.277	$\left(\frac{1.5}{c}\right)^2$	4.11
Niles	24		$\frac{3}{32}$	48	12	0.109				0.23	$\left(\frac{1.81}{c}\right)^2$	6.00
Grand Rapids	24	12	$\frac{1}{16}$	72	16	0.065	12	$\frac{1}{4}$	3 to $3\frac{3}{4}$	0.15	$\left(\frac{2.77}{c}\right)^2$	14.0
Minneapolis												
Old	24	12	$\frac{1}{16}$	72	16	0.065	12	$\frac{5}{16}$	3 to $3\frac{3}{4}$	0.15	$\left(\frac{2.77}{c}\right)^2$	14.0
New			$\frac{3}{32}$	48	14	0.083	4[2]			0.23		
Evânston	20	12	$\frac{3}{32}$	72	14	0.084	13[3]	$\frac{1}{4}$	3	0.34	$\left(\frac{1.02}{c}\right)^2$	1.9
Columbus	15	$8\frac{3}{4}$	$\frac{1}{16}$	45[1]		$\frac{1}{16}$		$\frac{3}{16}$		0.18	$\left(\frac{1.44}{c}\right)^2$	3.8

[1] Per plate, $8\frac{3}{4}$ in. centers both ways.

[2] Uses 12 in. spacing of $\frac{5}{16}$ in. U bolts and $8\frac{1}{2}$ in. spacing of $\frac{3}{8}$ in. hook bolts.

[3] Changed to $\frac{3}{8}$ in. bolts, 13 in., center to center.

[4] U bolts and yokes.

NOTE. Coefficient of discharge for orifice, "c," was selected at 0.74 from actual tests on similar orifices.

developments was exceedingly short filter runs, the loss of head building up to 10 feet in three hours, frequently in thirty minutes. Investigation showed that this was apparently caused by large amounts of diatoms present, chiefly Asterionella (400 to 2000 standard units per cc.). The interlacing arms of this organism made almost a water-tight mat on the surface of the filter. In order to keep the wash water within reasonable bounds, whenever the loss of head ran up to 8 feet or over, the bed was shaken up, by turning on the wash water and as quickly turning off. After two or three shakes, the bed had to be washed, but at periods usually three hours or more. With the diminution of the diatoms to less than 400 standard units per cc. in November, the runs lengthened to eight to sixteen hours.

With the low turbidity and low bacterial counts in the raw water, the removal of bacteria by the filters alone is not complete, 2 to 4

TABLE 3

Tests of strainer bolts

DIAMETER OF BOLT IN.	MAXIMUM STRENGTH		REMARKS
	Actual lb.	Lb. per sq. in.	
0.25	1075	40180	
0.375	5840	86190	
0.375	5140	75720	
0.373	5960	87650	Snapped. Brittle.
0.373	6190	91030	

NOTE. All broke at root of thread. All $\frac{3}{8}$ inch bolts Parsons bronze.

pounds of chloride of lime being used per million gallons as a finishing agent. The turbidity is entirely removed. With varying turbidities, and wide range of flow, the conditions to be met frequently tax the flexibility of the coagulating basins. A secondary application of coagulant just before the water is applied to the filter is of great service, giving a large heavy floc.

Contrary to expectations, the coagulant flocculates very readily, giving large heavy flocs with amounts of 0.6 gram per gallon and upward. In the preliminary laboratory tests of the original report, considerable difficulty was experienced in getting a good floc with low turbidities.

Running at a slight overload, the bacterial removal was over 90 per cent at times with less than 1000 bacteria per cc. on agar at 20 degrees C. in the raw water. With the lowering of the diatoms and the decrease in filter rate to a usual rating, the bacterial removal has increased. Generally 3 pounds of chloride of lime per million gallons, applied to the filtered water, proves effective as a finishing agent, removing all gas formers. One pound is too little.

Under winter conditions the wash water is averaging 3.2 to 4.3 per cent, with filter runs from four to sixteen hours long, the turbidity ranging from 7 to 50 p.p.m. In December, 1914, the results were as follows:

	AVERAGE	MAX.	MIN.
Turbidity raw water	20	40	7
Applied	15	40	4
Coagulant, gr. per gal	0.76	0.85	0.61
Chloride of lime, lb. per mil. gal	3.5	5.5	0.9
Per cent wash water	4.3	5.9	2.8
Length of run, hours	7.3	12.2	4.5
Bacteria per cc. (on agar 20 deg., 4 days)			
Raw water	664	2000	120
Settled water	464	1400	90
Filters	87	600	0
Plant	23	60	0

The treatment of the water at Evanston has largely eliminated typhoid. However, not enough time has elapsed to show the effect of filtration, but the results produced by the use of the "hypo" applied since January 1, 1912, are of interest. For this table the author is indebted to Prof. W. Lee Lewis, city chemist.

TABLE 4

Typhoid fever death rates per 10,000

YEAR	CHICAGO	EVANSTON
1907	17.5	21
1908	15	32
1909	12.5	28
1910	13	24
1911	10.8	28
1912	7.6	14.3
1913	10.6	13.3
1914	7.6	6.6

For convenience in keeping the operating records, several forms were devised, combining the good points of typical forms from many plants. These forms are given herewith. Forms 1 and 2 are for the filter attendant to fill in. Form 3 is filled in each day by the chemist or engineer in charge of the plant, giving a handy and complete summary at the end of each month.

DAILY FILTER RECORD EVANSTON ILL., FILTRATION PLANT DATE ______

RECORD OF FILTER RUNS AND WASHES

	FILTER NO. 1	FILTER NO. 2
RUN NO.		
RUN BEGAN		
L. H. AT START		
L. H. AT END		
RUN ENDED		
WASH — DEPTH IN TANK — START		
WASH — DEPTH IN TANK — FINISHED		
WASH — DEPTH IN TANK — USED		
WASH — MINUTES ON		

	FILTER NO. 3	FILTER NO. 4
RUN NO.		
RUN BEGAN		
L. H. AT START		
L. H. AT END		
RUN ENDED		
WASH — DEPTH IN TANK — START		
WASH — DEPTH IN TANK — FINISHED		
WASH — DEPTH IN TANK — USED		
WASH — MINUTES ON		

	FILTER NO. 5	FILTER NO. 6
RUN NO.		
RUN BEGAN		
L. H. AT START		
L. H. AT END		
RUN ENDED		
WASH — DEPTH IN TANK — START		
WASH — DEPTH IN TANK — FINISHED		
WASH — DEPTH IN TANK — USED		
WASH — MINUTES ON		

HOURLY LOSS OF HEAD

FILTER	1	2	3	4	5	6
MDT						
1: A						
2:						
3:						
4:						
5:						
6:						
7:						
8:						
9:						
10:						
11:						
NOON						
1: P						
2:						
3:						
4:						
5:						
6:						
7:						
8:						
9:						
10:						
11:						
MDT.						

REMARKS: ______

FORM 1. DAILY FILTER RECORD.

CHEMICAL AND GENERAL RECORD—EVANSTON, ILL., FILTRATION PLANT. Date________

HOUR	RATE-M. G. D.				ALUM DOSE					HYPO DOSE					REMARKS
	MASTER CONTROL		TOTAL FILTER RATE	VENTURI METER	MINUTE	ORIFICE NO	HEAD FT.	THOUSAND GALS 24 HRS.	GRS. GAL.	MINUTE	ORIFICE NO	HEAD FT.	THOUSAND GALS 24 HRS	LBS. M. G.	M. G TREATED ____
	MIN	READ													
MDT															V. M
1:A															
2:															
3:															
4:															
5:															
6:															
7:															
8:															
9:															
10:															
11:															
M															
1:P															
2:															
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4:															
5:															
6:															
7:															
8:															
9:															
10:															
11:															
MDT															V. M.

SOLUTION TANK RECORD

TANK NO.	1	2	3	A	B	C	
DEPTH AT MDT.							
CHARGING-START							
" FINISH							
DEPTH-START							
" FINISH							
" FILLED							
LBS. OF CHEMICAL							
LBS PER FT IN TANK							
DEPTH AT MDT							
PUT IN SERVICE							
DEPTH AFTER PARTLY FILLING FROM DISSOLVING TANK-A							

FORM 2. DAILY CHEMICAL AND GENERAL RECORD

MONTHLY SUMMARY OF OPERATIONS AND RESULTS

EVANSTON ILL. FILTRATION PLANT

MONTH OF________ 191_

Date	No. Filters On	HOURS			MILL. GALS. TREATED	Av. Filter Rate M.G.D.	Yield per Run Mill. Gals.	Loss of Head		WASHES					ALUM						HYPO				BASIN OPERATION			Temp. °F.-Raw.	ODOR		TURBIDITY p.p.m.			BACTERIA-20°C Gelatin-48 Hrs.				BACTERIA-39°C Lt. Lac. Agar-24 Hrs.						B. Coli Index No. per c.c. Lac. Broth 24 Hours			Micro-organisms Std. Units per c.c.					
												Thou. Gals			Pounds		Grs. per Gal.				Pounds		Lbs. per M.G.															TOTAL			ACID						RAW		INFLUENT			
		Plant Service	Filter-hrs.	Run Length				Initial	Final	Minutes On per Wash	Number	Total	Per Wash	Per Cent	Mixed	Used	Mixing Basin	2nd. Coagulant	At Filters	Total	Mixed	Used	Total Hypo	Available Cl.	M.B.	North C.B.	South C.B.		Raw.	Clear Wells	Raw	Influent	Effluent	Raw	Influent	Effluent	C.W.	Raw	Eff.	C.W.	Raw	Eff.	C.W.	Raw	Eff.	C.W.	Amorp. Matter	Organisms	Amorp. Matter	Organisms		
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Max.																																																				
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Form 3. Monthly Summary